JP 10-99247

Translated from Japanese by the Ralph McElroy Co., Custom Division
P.O. Box 4828, Austin, Texas 78765 USA

Code: 282-66623

JAPANESE PATENT OFFICE

PATENT JOURNAL

JAPANESE KOKAI PATENT APPLICATION NO. HEI 10[1998]-99247

Int. Cl.[6]: A 47 L 13/16
B 32 B 3/26
//A 61 L 2/18
A 47 l 13/16
B 32 B 3/26
A 61 L 2/18

Application No.: Hei 8[1996]-257032

Application Date: September 27, 1996

Publication Date: April 21, 1998

No. of Claims: 7 (Total of 10 pages; OL)

Examination Request: Not requested

# WIPING SHEET

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Abstract

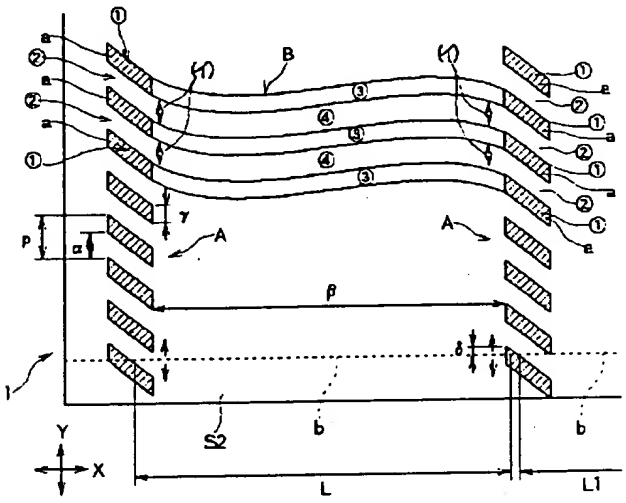
Problem

Because wiping sheets intended for household cleaning, sanitary toilet use, or for toweling have been used which are made by simply laminating flat sheets on top of one another, they have low bulkiness, are difficult to hold by hand, and are difficult to use to wipe up contamination in locations with irregular surfaces.

Means of solution

Highly creped second sheets S2, which have a higher ratio of elongation than a first sheet S1, are bonded to both sides of the above sheet S1, which has not been subjected to creping or has been subjected to low creping with a low ratio of elongation when impregnated with liquid, and are partially adhesively bonded using short bonding sections (a) oriented at an angle to the direction in which the crepe wrinkles extend. In addition, bonding sections A are formed in parallel to each other by rows of short bonding sections (a). When the first and second sheets

S1 and S2 are impregnated with a detergent, due to the difference in the ratio of elongation of the sheets S1 and sheet S2, bulges are generated in the second sheets S2 between bonding sections A. As a result, a bulky wet sheet can be formed.




Claims

1. A wiping sheet which is characterized by the fact that a plurality of sheets are stacked and the sheets are partially bonded by a plurality of bonding sections, with the above mentioned bonding sections lined up in spaced-apart rows, and that there are provided multiple rows of such bonding sections with a specified interval therebetween, with wrinkles of repeating ridges and valleys formed with almost the same pitch as the pitch of the aforementioned bonding sections with respect to the direction of the rows in the region between the rows of the

aforementioned bonding sections at least on the sheets exposed on the surface.

2. A wiping sheet which is characterized by the fact that a first sheet which has a low crepe ratio or with no crepe and second sheets with a higher crepe ratio than the aforementioned first sheet are partially bonded using a plurality of bonding sections, with the aforementioned bonding sections lined up in spaced-apart rows, and that there are provided multiple rows of such bonding sections with a specified interval therebetween, and, because of the difference in the ratio of elongation due to the reversal of crepe on both sheets after the two sheets have been bonded, there are wrinkles of repeating ridges and valleys formed with almost the same pitch as the pitch of the aforementioned bonding sections with respect to the direction of the rows in the region between the rows of the aforementioned bonding sections at least on the sheets exposed on the surface.

3. The wiping sheet according to Claim 2, in which second sheets are bonded to both the front and reverse side of the first sheet.

4. The wiping sheet according to any of Claims 1-3, in which bonding sections are shaped as short linear segments, with the bonding sections formed so that they are inclined with respect to the direction of the rows.

5. The wiping sheet according to any of Claims 1-4, in which the interval between adjoining bonding sections in the direction of the rows is not less than 0.5 mm and not more than 3.0 mm.

6. The wiping sheet according to any of Claims 1-5, in which the interval between the rows of bonding sections is not less than 5.0 mm and not more than 15.0 mm.

7. The wiping sheet according to any of Claims 1-6, in which the weight per area of the sheet is not less than 15 g/m$^2$ and not more than 75 g/m$^2$.

Detailed explanation of the invention

[0001]

Field of industrial application

The present invention is concerned with a wet or dry wiping sheet used for flush toilet cleaning, disinfection or sterilization, or for the human body as toilet paper, or for household cleaning or for toweling, and in particular relates to a wiping sheet made bulkier and easier to handle, as well as possessing improved efficiency in terms of wiping up contamination.

[0002]

Prior art

Wet sheets have been used for toilet and household cleaning or for toweling. This wet sheet is a sheet obtained by impregnating a sheet of paper formed from wood pulp fiber and the like with a liquid detergent. Surface active agents, detergent components, antiseptics, fragrances, and the like are contained in water and alcohol in the aforementioned detergent liquid.

[0003]

Problem to be solved by the invention

With prior-art wet sheets, either a single flat sheet or 2, 3 sheets were used by laminating them on top of one another. For this reason, the bulkiness of the sheets themselves was low, and they were extremely thin. Therefore, when the sheet was used to wipe locations to be cleaned by pressing it against a surfaces with one's hand, it was impossible to obtain a tactile sensation of holding the sheet in one's hand, so that, for instance, one's hand was liable to slip against the sheet. The tactile sensation provided during use was inadequate. In addition, with flat wet sheets it was impossible to completely wipe contamination from locations to be cleaned. In particular, when wiping a floor and such with ridges and valleys, contamination in depressions was difficult to wipe up. In addition, there have been sheets obtained by laminating 2, 3 flats sheets on top of one another, and subjecting the sheets to embossing. Such thin sheets with ridges and valleys were not sufficiently improved in terms of difficulty in handling when wiping by applying pressure with one's hand because of the low bulkiness of the entire sheet. Thin embossed sheets are also limited in terms of improvement in the efficiency of wiping away contamination.

[0004]

The present invention overcomes the above described prior-art problems, and its objective is to provide a wiping sheet constructed in such a manner that it is easy to hold by

hand during cleaning and a tactile sensation close to that of a piece of cloth can be obtained by providing bulk in the construction of the wiping sheet which can be used either in a wet or a dry form.

[0005]

Furthermore, it is an object of the present invention to provide a wiping sheet which not only is less liable to slip out of one's hand, but also increases the efficiency of wiping away contamination in locations to be cleaned by creating fine wrinkles on the surface of the bulky sheet and forming a plurality of ridges and valleys on the surface of the sheet with these wrinkles.

[0006]

Means to solve the problems

The wiping sheet of the present invention is a sheet which is characterized by the fact that a plurality of sheets are stacked and the sheets are partially bonded by a plurality of bonding sections, with the above mentioned bonding sections lined up in spaced-apart rows, and that there are provided multiple rows of such bonding sections with a specified interval therebetween, with wrinkles of repeating ridges and valleys formed with almost the same pitch as the pitch of the aforementioned bonding sections with respect to the direction of the rows in the region between the rows of the aforementioned bonding sections at least on the sheets exposed on the surface.

[0007]

For instance, the wiping sheet of the present invention is a wiping sheet which is characterized by the fact that a first sheet which has a low crepe ratio or does not have any creping and second sheets of a higher crepe ratio than the aforementioned first sheet are partially bonded using a plurality of bonding sections, with the aforementioned bonding sections lined up in spaced-apart rows, and that there are provided multiple rows of such bonding sections with a specified interval therebetween, and because of the difference in the ratio of elongation due to the reversal of crepe on both sheets after two sheets have been bonded, there are wrinkles of repeating ridges and valleys formed with almost the same pitch as the pitch of the aforementioned bonding sections with respect to the direction of the rows in the region between the rows of the aforementioned bonding sections at least on the sheets exposed on the surface.

[0008]

It is preferable to use a three-layer construction, in which second sheets are bonded to both the front and reverse sides of the aforementioned first sheet. However, the construction may also be a two-layer structure of a first sheet and a second sheet.

[0009]

As described above, each of the bonding sections is a short bonding section shaped in the form of a short linear segment, and it is preferable for the bonding sections (short bonding sections) to be formed at an inclination to the direction of the rows.

[0010]

Furthermore, although in Figure 1 and Figure 2 the bonding sections (short bonding sections (a)) are lined up in rows with a constant pitch p in the direction of the rows, the pitch p in the direction of the rows, however, may vary for the bonding sections (short bonding sections (a)), and alternatively, the pitch p may periodically vary in the direction of the rows. Furthermore, although in Figure 1 and Figure 2, the rows of bonding sections extend in the direction Y in a rectilinear fashion, the rows of bonding sections are not necessarily rectilinear, so that the aforementioned rows may extend in the form of curved or segmented lines.

[0011]

In the present invention, along with forming a wiping sheet for toweling, for cleaning in a wet condition or a dry condition, and for other purposes by means of laminating a plurality of sheets of paper or unwoven fabric on top of one another, ridge-and-valley wrinkling is formed in a regular fashion at least on the sheets that are on the surface in order to impart a

bulky feel to the entire body thereof. Wiping effects are increased by the provision of regular ridge-and-valley wrinkling.

[0012]

For the multiple sheets, the ridge-and-valley wrinkling is created in a regular fashion at least on the surface sheets, and as structures intended for controlling the pitch and intervals between the ridge-and-valley wrinkles, bonding sections are arranged with an interval $\alpha$ in the direction of the rows, for instance, with a constant pitch p or a periodically changing pitch, and there are provided multiple rows, in which multiple bonding sections are lined up, with a specified interval $\beta$ therebetween. Based on this, in the regions between the aforementioned rows, control is exercised in such a manner that depressed sections appear in the sheet in the portions where the bonding sections are, and protruding sections appear between the bonding sections, so that wrinkles of repeating irregularity can be produced with almost the same pitch as the arrangement pitch p of the bonding sections.

[0013]

Concerning the method for creating ridge-and-valley wrinkling corresponding to the pitch of the aforementioned bonding sections at least on the surface sheets, it is possible to subject the sheets to wrinkling when bonding the sheets at a specified pitch and to form ridge-and-valley wrinkling corresponding to the pitch of the bonding sections while bonding the sheets using the bonding sections.

[0014]

In addition, a first sheet, which has a low crepe ratio or has no creping, and second sheets with a higher crepe ratio than the aforementioned first sheet are bonded to each other using the aforementioned bonding sections. In this case, this may be a three-layer structure, in which second sheets are bonded both to the front and reverse sides of the first sheet, or a two-layer structure, in which only a first sheet and a second sheet are bonded. When moisture is applied to the sheets after bonding the sheets using multiple bonding sections, such as the ones shown in Figure 2, crepe wrinkles form, and the sheet extends, with the ratio of elongation of the second sheets being, however, greater than the ratio of elongation of the first sheet. Thus, elongation takes place in the second sheets while being restrained by the first sheet, and as a result, the second sheets produce bulges on top of the first sheet. As shown in Figure 2, in the portion, where the bonding sections are formed, the elongation of the second sheets is restrained, with the elongation of the second sheets increasing between the bonding sections, so that as a result, in the regions between the rows of bonding sections, on the edges, there are depressions in the portions where there are bonding sections and bulges in the portions where there are none, so that a ridge-and-valley wrinkling with almost the same pitch as the arrangement pitch p of the bonding sections is present.

[0015]

In addition, when each bonding section is a short linear segment and these bonding sections are formed so that they are inclined with respect to the arrangement pitch, crepe wrinkles do not short circuit between the regions on each side of the bonding sections, and ridge-and-valley wrinkling corresponding to the arrangement pitch of the bonding sections is formed in the regions between the rows of bonding sections by sandwiching the rows of bonding section, independently from the adjacent regions.

[0016]

The sheet of the present invention, for instance, is made of paper containing chemical fibers, such as rayon, or paper of natural pulp (wood pulp) which has been subjected to the above mentioned creping. Alternatively, it may be made of unwoven fabric.

[0017]

Bonding between the sheets may be adhesive bonding based on the use of EVA and other hot melt adhesives. Alternatively, when the sheets are formed out of polyethylene (PE), polypropylene (PP), and other polyolefinic resin fibers or composite fibers comprising them, bonding between the sheets may be based on the thermal fusion of the above mentioned fibers.

[0018]

When the sheets are bonded using a water-insoluble bonding means, such as hot-melt adhesives or thermal fusion, the bonding between the sheets obtained by using the above mentioned bonding means is not destroyed by the detergent liquids contained in the sheets. Liquids containing surface active agents, detergent components, antiseptics, fragrances, and the like in water and alcohol are used as the detergent liquids. Alternatively, the product may be sold in a dry state, with the user impregnating it with water or the aforementioned detergent liquid. If it is sold as a dry sheet, bulges are formed in the second sheet by impregnation with water and such, followed by drying the sheet with hot air and such. Because the wrinkles are preserved after drying, the bulky feeling of the sheet is not impaired.

[0019]

In addition, when sheet is made up of hydrolyzable sheets (hydrolyzable paper) consisting of natural pulp and other fibers and carboxymethylated pulp or carboxymethylcellulose and other water-soluble or water-swellable binders to be thrown in a flush toilet, the aforementioned bonding sections are formed by adhering sheets using water-soluble adhesives, such as carboxymethylcellulose and the like. In this case, a liquid, in which an alcohol, as well as calcium, strontium and other metal ions, are contained in water, is used as the detergent liquid contained in the sheet. The dissolution of the adhesive and breakdown of the sheet by the reagent solution, with which the sheet has been impregnated, are suppressed by the metal ions, and

during use the strength of the sheet can be preserved. After being thrown in a flush toilet, the detergent liquid is diluted by water, and this allows hydrolysis of the sheet and breakdown of the adhesive.

[0020]

The wiping effects obtained by using this wiping sheet depend on the pitch of the ridge-and-valley wrinkling on the sheet surface, and as was described above, the ridge-and-valley wrinkling of the sheet is controlled by the interval $\alpha$ between the bonding sections and the arrangement pitch p in the direction of the rows of bonding sections. As a result of experiments, it has been found that in order to efficiently produce wiping effects, it is preferable that the interval $\alpha$ in the direction of the rows of bonding sections should be not less than 0.5 mm and not more than 3.0 mm. In addition, when the interval $\beta$ between the rows of bonding sections is too wide, the strength of the ridge-and-valley wrinkling between the rows is weakened and the wiping effects due to the ridge-and-valley wrinkling decrease. When the interval $\beta$ between the rows is too narrow, the height of the ridge-and-valley wrinkling between the rows is decreased. Thus, it is preferable that the interval $\beta$ between the rows of bonding sections should be not less than 7.5 mm and not more than 15.0 mm.

[0021]

The above mentioned interval $\alpha$ in the direction of the rows of bonding sections (and pitch p) and the interval $\beta$ between the

rows of bonding sections affect the bulky feel of the sheet. Furthermore, the difference in elongation due to the reversal of the crepe wrinkles in the first sheet and elongation due to the reversal of the crepe wrinkles in the second sheets affects the bulky feel. To impart appropriate bulges between the first sheet and second sheet, the difference in ratio elongation of the first sheet and second sheets should preferably be not less than 20% and not more than 80%, and, more preferably, not less than 30% and not more than 60%. The ratio of elongation here is represented by the formula $\{(\Delta x - x)/x\}\times 100$ (%), where the original length of the sheet is designated as x, and the length of the sheet after it has been immersed in a liquid to reverse the crepe and expand is designated as $\Delta x$.

[0022]

In addition, the flexibility and strength of the sheet vary depending on the weight per area of the first sheet and second sheets, and in the present invention, it is preferable that the respective weight per area of the first and second sheets should be not less than 15 $g/m^2$ and not more than 75 $g/m^2$. When this type of sheet is used, in the case of a sheet with two-layer construction made up of a first sheet and a second sheet, the total weight per area of the sheet is not less than 30 $g/m^2$ and not more than 150 $g/m^2$, In the case of a sheet with three-layer construction made up of second sheets bonded to both the front and reverse side of a first sheet, the total weight per area is not less than 45 $g/m^2$ and not more than 225 $g/m^2$.

[0023]

Using this type of construction allows realization of a wiping sheet that is bulky, has wrinkles appropriately formed thereon, is easily grippable, and has a high wiping efficiency.

[0024]

Embodiments

Embodiments of the present invention are explained herein below by referring to figures. Figure 1 is an oblique view that shows the construction of the wiping sheet of the present invention. This wiping sheet is used for housecleaning, such as toilet or kitchen cleaning, for toilet sanitary use, or for toweling, and is used in the form of a water-insoluble wet sheet impregnated with a detergent liquid, a water-soluble wet sheet that can be flushed in a flush toilet after wiping away contamination, or as a dry sheet used in a dry state.

[0025]

The aforementioned wiping sheet (1) has a three-layer construction made up of a first sheet (S1) and second sheets (S2) partially adhesive-bonded to the both the front and reverse sides of the first sheet (S1) via adhesive bonding sections (A). The first sheet (S1) is a sheet obtained by subjecting a raw paper sheet formed in accordance with a wet technique from pulp fiber to creping or without creping, and the second sheets (S2) are sheets obtained by subjecting the raw paper sheet to creping with

a higher ratio of elongation that that of the first sheet (S1). The above mentioned adhesive bonding sections (A) are provided, with a constant interval in the direction X, in a rectilinear fashion in the direction Y (direction of the rows). When the wiping sheet (1) impregnated with a detergent liquid is wet, the fine wrinkling produced by creping reverses and the sheet extends; the second sheets (S2, S2), however, possess a higher ratio of elongation than the first sheet (S1), and, moreover, because the first sheet (S1) and second sheets (S2) are mutually partially restrained by the adhesive bonding sections (A), the second sheets (S2) undergo bulging deformation in the regions between bonding section (A) and bonding section (A). Furthermore, fine wrinkling (B) appears on the second sheets (S2).

[0026]

Figure 2, by enlarging a portion of Figure 1, schematically shows the shape of the adhesive bonding sections (A) and the wrinkling present thereon, with the X-Y axis in Figure 2 corresponding to the X-Y axis in Figure 1. Direction Y is the direction of take-up in the process of papermaking, and direction X is the width direction. Direction X is the direction in which extends the fine wrinkling (b) produced by creping (the crepe direction).

[0027]

As shown in Figure 2, concerning the aforementioned adhesive bonding sections (A), multiple short bonding sections (a) shaped as short linear segments are arranged in such a manner that they

form rows with a constant pitch p in direction Y, with the first sheet (S1) and second sheets (S2) partially adhesively bonded by the short bonding sections (a). In addition, the interval between adjacent short bonding sections (a) lined up in the direction of the rows is indicated with the letter $\alpha$. The short bonding sections (a) are formed so that they are inclined at an angle with respect to both the direction of the aforementioned pitch p (direction Y) and the crepe direction (direction X). In addition, the interval between rows (rows Y [sic; A]) of short bonding sections (a) is indicated with the letter $\beta$.

[0028]

When the sheets (S1, S2, S2) are impregnated with a detergent liquid, fine wrinkling (b) produced by creping tends to swell in the direction Y. Because at such time the first sheet (S1) and second sheets (S2) are adhered to each other via portion ① of the short bonding sections (a), elongation in direction Y is not liable to occur in the second sheets (S2) in this portion ①. By contrast, in the portion ② of the interval $\alpha$ sandwiched between a short bonding section (a) and a short bonding section (a), the second sheets (S2) readily extend in direction Y, and loosening is liable to be generated in the portion ② due to the elongation (i) in direction Y. As a result, valley sections ③ are formed in a belt-like fashion in the portions connecting the short bonding sections (a) and ridge sections ④ appear in a belt-like fashion connecting portions ② on both sides of the region sandwiched between adhesive bonding sections (A) and adhesive bonding sections (A), in other words, regions L between the rows which the short bonding sections (a) form. Thus, the L

region sandwiched between the rows which the short bonding sections (a) form has wrinkling B of ridges and valleys repeating with practically the same pitch as the arrangement pitch p of the short bonding sections (a). In addition, the width dimensions in direction Y of the ridge sections ④ of wrinkling B are determined by the aforementioned interval $\alpha$ of the short bonding sections (a) and the width dimensions of the valley sections ③ in direction Y are determined by the width dimension $\gamma$ in direction Y of the short bonding sections (a).

[0029]

In addition, the short bonding sections (a) are formed so as to be inclined at an angle to the arrangement pitch direction (direction Y) and the crepe-forming direction (direction X), and, furthermore, when one views the short bonding sections (a) lined up in direction Y, there is an overlap $\delta$ between short bonding section (a) and short bonding section (a) in direction Y. For this reason, crepe wrinkles (b) in the region L between the rows and crepe wrinkles (b) in the neighboring region L1 between rows are necessarily shielded by the slanted short bonding sections (a) serving as a boundary, so that not a single crepe wrinkle (b) continues uninterrupted between region L and the neighboring region L1. To explain this, as shown in Fig. 2 with a dotted line (b) indicating a single crepe wrinkle, no matter where the dotted line (b) is drawn, the dotted line (b) extending between region L and region L1 will be shielded by a short bonding section (a). Therefore, ridge-and-valley wrinkling (B) of the second sheets (S2) is formed independently in region L and region L1. Due to the fact that ridge-and-valley wrinkling (B) is formed

independently in region L and region L1, the stiffness of the ridge-and-valley wrinkling (B) can be increased, and a strength may be imparted thereto that is sufficient to make it resistant to collapse. Because the wrinkling (B) is produced in a reliable fashion, a voluminous feel is imparted to the entire wiping sheet (1) as shown in Fig. 1. In addition, because of the wrinkling (B), it becomes easier to hold the wiping sheet by hand, and the efficiency of wiping away contaminants increases because of the ridges and valleys that appear in the sheet (1) due to the wrinkling (B).

[0030]

In order to effectively create constant ridge-and-valley wrinkling (B) on the second sheets (S2) which have a high ratio of elongation, it is preferable to set a constant pitch p of the short bonding sections (a) lined up in direction Y. However, the pitch p may also vary in a periodic fashion. In addition, although the width dimension of the ridge sections ④ in direction Y is determined based on the interval α between portions ② of the short bonding sections (a), if the interval α is too large, the width of the ridge sections ④ becomes excessively large so that the bulge produced by the ridge sections ④ is liable to collapse and the ridge sections ④ of the wrinkling (B) are subjected to deformation flattening when used for continuous wiping. This decreases the efficiency of contaminant wiping. Conversely, if the interval α is too narrow, the width of the ridge sections ④ becomes too small so that the bulge of the wrinkling (B) drops, the efficiency of wiping decreases, and the feel of sheet bulkiness disappears.

[0031]

Thus, in order to make the sheet bulkier by imparting an appropriate bulge to the ridge sections ④ and to increase the efficiency of wiping, it is preferable that the interval α between short bonding sections (a) lined up in direction Y should be not less than 0.5 mm and not more than 3.0 mm. However, even when the interval α is not less than 0.5 mm and not more than 5.0 mm, sufficient effects can be expected in comparison with prior-art sheet, and even at up to 10.0 mm the only problem is wrinkle collapse. Thus, the interval α may be not less than 0.5 and not more than 5.0 mm, or not less than 0.5 mm and not more than 10.0 mm.

[0032]

On the other hand, the dimension γ of the short bonding sections (a) affects the dimensions of the ridge-and-valley wrinkling (B) in direction Y. When the aforementioned dimension γ is too large, the area occupied by the valley sections ③ on the entire sheet becomes too large, the bulky feel of the sheet disappears, and the number of ridge sections ④ drops, decreasing wiping efficiency. Thus, it is preferable to make the dimensions of the valley sections ③ identical to or smaller than the dimensions of the ridge sections ④, and, for this reason, it is necessary to make the dimension γ of the short bonding sections (a) identical to or smaller than the interval α. Furthermore, the extent to which wrinkling (B) of the sheet (1) is formed and the extent to which the bulge is formed are regulated by the

interval β between the rows which the short bonding sections (a) form, in other words, the interval between an adhesive bonding section (A) extending in direction Y and the next adhesive bonding section (A) parallel thereto.

[0033]

When the aforementioned interval β between rows is too large, the width dimension of the region L between the rows increases and the wrinkles (B) in the region L are made longer, which weakens the stiffness of the ridges and valleys of the wrinkles (B). Therefore, the wrinkles (B) tend to collapse easily when wiping away contaminants. Conversely, if the interval β between rows is too narrow, the proportion of the surface area of adhesive bonding sections (A) with respect to the surface area on which bulging of the ridge-and-valley wrinkling (B) is produced becomes too large, and the sheet begins to lack a bulky feel. Thus, it is preferable that the interval β between rows of short bonding sections (a) should be not less than 7.5 mm and not more than 15.0 mm. However, even if the interval β reaches 20.0 mm, with the exception of the fact that the wrinkling is prone to collapse, superior wiping effects are displayed as compared with prior-art wiping sheet.

[0034]

Figure 3 (A), (B), (C) shows an example of a method for manufacture of wiping sheet (1) in step order. First of all, as shown in Figure 3 (A), an adhesive (2) is applied to both the front and reverse sides of the first sheet (S1) with low crepe or

without crepe, and second sheets (S2, S2) are laminated on both the front and reverse sides of the first sheet (S1). The first sheet (S1) and second sheets (S2) are sheets manufactured using a wet papermaking technique utilizing papermaking machines and are based on the use of wood pulp fiber, non-wood pulp fiber, or rayon fiber and the like as the raw material followed by creping of the sheets. As was mentioned above, the ratio of elongation of the sheets (S2) is made higher than the ratio of elongation of the sheet (S1).

[0035]

In order to create an appropriate bulge between the rows of short bonding sections on the second sheets (S2), it is preferable that the difference in the ratio of elongation due to the reversal of the crepe wrinkling of the first sheet (S1) and second sheets (S2) should be not less than 20% and not more than 80%, and even more preferably, not less than 30% and not more than 60%. If the ratio of elongation is smaller than the above-mentioned range, the entire wiping sheet (1) cannot be made sufficiently bulky, and if it exceeds the above-mentioned range, the bulging of the second sheets (S2) becomes excessively pronounced, the ridge sections ④ of the ridge-and-valley wrinkling (B) are too high, the stiffness of the ridge sections ④ is weakened, and they are liable to collapse. In addition, when the thickness of the wiping sheet (1) is too large and sheets are stacked in a container, swelling takes place in the container.

[0036]

Also, when the weight per area of the first sheet (S1) and second sheets (S2) is excessively large, the flexility of the sheet becomes low. The sheet becomes stiff and hard to use in wiping contaminants. If weight per area is too small, the sheet may be ruptured in the process of wiping, and there may be other problems. Therefore, it is preferable that the weight per area of the first and second sheets should be not less than 15 $g/m^2$ and not more than 75 $g/m^2$. When this type of sheet is used, in the case of a sheet with a two-layer structure comprising a first sheet and a second sheet, the total weight per area of the sheet is not less than 30 $g/m^2$ and not more than 150 $g/m^2$, and in the case of a sheet with a three-layer structure, in which second sheets are bonded to the front and reverse sides of the first sheet, the total weight per area is not less than 45 $g/m^2$ and not more than 225 $g/m^2$.

[0037]

An adhesive (2) is applied to the first sheet (S1) so as to obtain the bonding pattern shown in Figure 2, with water-insoluble polyethylene, polypropylene, and other polyolefinic and EVA hot melt adhesives used as the adhesive. In addition, in case sheets S1 and S2 are hydrolyzable sheets, water-soluble carboxymethylcellulose and the like are used as the adhesive. Then, upon application of the adhesive, second sheets (S2, S2) are laminated on both the front and reverse sides of the first sheet (S1) and the [wiping] sheet is interposed between heating plates (4) and (5) while moistening it. An embossing (5a)

that matches the pattern of the adhesive bonding sections (A) is provided on the heating plate (5) and the sheet is subjected to pressure and heating by the embossing (5*a*) so that the first sheet (S1) and the second sheets (S2) are mutually adhesively bonded via the adhesive bonding sections (A). The bonded state is shown in Figure 3 (B).

[0038]

The thus laminated wiping sheet (1) is impregnated with a detergent liquid (including hydrolysis-suppressing components, such as metal ions, in the case of a hydrolyzable sheet) obtained by mixing water with alcohol, surface active agents, antiseptics, deodorants, fragrances, and the like. When it is impregnated with the detergent liquid, fine wrinkling (b) produced by creping swells in direction Y, and, as shown in Figure 2, second sheets (S2) extend in direction Y in portions ② between a short bonding section (a) and the next short bonding section (a). Valley sections ③ appear, connecting portions ① of the short bonding sections (a), and ridge sections ④ appear, connecting portions ② in the region L between one adhesive bonding section (A) and the next adhesive bonding section (A) arranged in direction Y, and, in the region L between the adhesive bonding sections (a), ridge-and-valley wrinkling (B) appears, practically matching the arrangement pitch p of the short bonding sections (a). The thus formed wiping sheet (1) is placed in a plastic container or such in a wet state impregnated with a detergent liquid.

[0039]

In addition, the aforementioned wiping sheet (1) is not limited to wet sheet and may be dry sheet. In this case, in the above-mentioned manufacturing process, upon adhesion bonding of the first sheet (S1) and second sheets (S2), it is impregnated with the aforementioned detergent liquid or a disinfecting or sterilizing solution, as well as anti-mold agents and the like, and wrinkling (B) is formed on the second sheets (S2). Then, the wiping sheet may be dried with hot air or the like. In this manner, even after the wiping sheet (1) has been dried, the aforementioned wrinkling (B) maintains its bulge, so that the sheet is imparted with bulkiness. In addition, as shown in Fig. 4, a two-layer construction may be used, in which a first sheet (S1), which has been subjected to creping with a low ratio of elongation or has not been subjected to creping at all, and a second sheet (S2) which has been subjected to creping with a high ratio of elongation, are, respectively, laminated on top of one another.

[0040]

Application examples

To produce the wiping sheet (1) of the present invention, the interval $\alpha$ between adjacent short bonding sections (a) in the direction of the rows was made not less than 0.5 mm and not more than 3.0 mm, the interval $\beta$ between the rows of the adhesive bonding sections (a) was made not less than 5.0 mm and not more than 15 mm, the optimum weight per area of the first and second

sheets (S1, S2) was made not less than 15 g/m$^2$ and not more than 75 g/m$^2$, and the following wiping tests were carried out in order to investigate wiping efficiency, flexibility, and bulkiness (thickness) of the wiping sheet formed under such conditions.

[0041]

(1) Tests regarding the interval α between short bonding sections (a) in the row direction

First of all, the following tests were carried out in order to study the interval α between short bonding sections (a), at which the bulky feel of the wiping sheet can be maintained and appropriate wrinkling (ridges and valleys) produced by the elongation of the crepe can be formed. A high-crepe paper with a crepe ratio of 50% and a weight per area of 60 g/m$^2$ made of pulp fiber was used for the second sheets and a paper with no crepe also made of pulp fiber with a weight per area of 30 g/m$^2$ was used for the first sheet. The front and reverse sides of the first sheet were partially coated with an adhesive, the second sheets were laminated on the front and reverse sides of the first sheet, and, by applying pressure with a heating plate as shown in Figure 3 (A), the sheets were bonded to form a wiping sheet with a three-layer structure.

[0042]

Five types of application examples were manufactured, in which the interval α between the short bonding sections (a) of the second sheets and first sheet was 0.6 mm, 1.5 mm, 3.0 mm,

5.0 mm, and 10.0 mm. In all cases, the interval β between the rows of short bonding sections (a) was 7.5 mm. After the adhesion-bonding of the first and second sheets, the resulting sheet was impregnated with a detergent liquid, in which alcohol was contained in a water medium to produce bulging due to elongation of crepe wrinkles in the second sheets.

[0043]

A kitchen tiled floor was used as the object of testing (object to be wiped) in the wiping tests. The surface area of the floor used for carrying out the tests was 500 mm × 500 mm, with the protruding sections of the tiles being 28 mm × 28 mm squares and the depth of the groove sections in between being 0.85 mm. An appropriate amount of dust and pulp was scattered on the floor and in each application example the floor was wiped five times. The condition of the floor after wiping was observed, and an evaluation using symbols ○, △, and × was carried out concerning the extent to which pulp and dust contaminants in the groove sections had been removed. After wiping, the state of collapse of the wrinkling on the side of the sheet that had been used for wiping was observed, and an evaluation was carried out using the symbol ○ if the degree of collapse was small, △ if there was some collapse, and × for cases where considerable collapse had occurred. Furthermore, the thickness of the wiping sheet was measured prior to the wiping operation. The results of the tests above are shown in Table I hereinbelow.

[0044]

Table I

| ① 短接合部列方向の間隔α (mm) | | 0.6 | 1.5 | 3.0 | 5.0 | 10.0 |
|---|---|---|---|---|---|---|
| ② 拭き取り試験 | ダスト ③ | ○ | ○ | ○ | △ | △ |
| | 開繊パルプ ④ | ○ | ○ | ○ | ○ | ○ |
| ⑤ 拭き取り後のシワの潰れ度合 | | ○ | ○ | △ | △ | × |
| ⑥ 見掛け厚み (mm) | | 2.43 | 2.14 | 2.06 | 2.00 | 1.90 |

Key: 1 Interval α (mm) between short bonding sections in the row direction
2 Wiping test
3 Dust
4 Pulp
5 Degree of collapse of wrinkles after wiping
6 Apparent thickness (mm)

[0045]

As shown in Table I, the sample, in which the interval α between the short bonding sections (a) was 0.6 mm, had a relatively large apparent wiping sheet thickness of 2.43 mm and was bulky. In addition, the shape of the ridge-and-valley wrinkling (B) was adequate with efficient wiping of dust and wiping of pulp. The strength of the ridge-and-valley wrinkling (B) was also high (high stiffness), and the wrinkling was not

liable to collapse during wiping and wiping could be carried out while preserving its height. In the sample that had an interval α of 1.5 mm the thickness of the sheet was 2.14 mm so its bulkiness was slightly lower as compared with the sample that had a pitch of 0.6 mm. Dust and pulp, however, could be cleanly wiped, wrinkling was not liable to collapse and the sample was easy to handle.

[0046]

In the sample that had an interval α of 3.0 mm between short bonding sections the ridge sections ④ of the ridge-and-valley wrinkling (B) had a significant width, overall bulkiness decreased, and thickness was just 2.06 mm. In addition, because the width of the ridge sections ④ of the ridge-and-valley wrinkling (B) was too large, the stiffness of the ridge sections ④ was low, and they tended to collapse readily during wiping. In the sample that had an interval α of 5.0 mm between short bonding sections, the ridge sections ④ of the ridge-and-valley wrinkling (B) were even wider, which resulted in lower bulkiness and a thickness of just 2.0 mm. In addition, because of the significant width of the ridge sections ④, the stiffness of the wrinkles was diminished, they were prone to collapse, and results from the dust wiping test were also somewhat inferior.

[0047]

When the interval α between the short bonding sections was 10.0 mm, the ridge sections ④ of the ridge-and-valley wrinkling

(B) were broad, and the thickness of the sheet was just 1.9 mm. In addition, the number of ridges and valleys was reduced, the results of the test aimed at evaluating the wiping of fine contaminants, such as dust, were somewhat inferior, and the wrinkling had a tendency to collapse after wiping. As can be seen from the above, in order to achieve high bulkiness, make the ridge-and-valley wrinkling (B) less prone to collapse in the process of wiping, and to increase the efficiency of wiping, the interval $\alpha$ between short bonding sections (a) in the direction of the rows should be preferably not less than 0.5 mm and not more than 3.0 mm. However, wiping effects comparable to those of prior-art sheets can be fully expected even if the interval $\alpha$ is not less than 0.5 mm and not more 5.0 mm, and even if it reaches 10.0 mm, there are no problems except for the collapse of wrinkling. Thus, the interval $\alpha$ may be not less than 0.5 mm and not more than 5.0 mm, or not less than 0.5 mm and not less than 10.0 mm.

[0048]

(2) Tests regarding the interval between the rows of short bonding sections

The following tests were carried out in order to investigate the interval $\beta$ between rows of short bonding sections (a), at which the bulky feel of the wiping sheet can be maintained and appropriate wrinkling (ridges and valleys) produced by the elongation of the crepe wrinkles can be formed. A high-crepe paper with a crepe ratio of 50% and a weight per area of 60 $g/m^2$ made from pulp fiber was used for the second sheets and a paper

with no crepe also made from pulp fiber with a weight per area of 30 $g/m^2$ was used for the first sheet. The front and reverse sides of the first sheet were partially coated with an adhesive, the second sheets were laminated on the front and reverse sides of the first sheet, and, by applying pressure with a heating plate as shown in Figure 3 (A), the sheets were bonded, forming a wiping sheet with a three-layer structure. Based on the results of the above-mentioned test (1), the interval $\alpha$ between the short bonding sections bonding the first sheet with the second sheets was set at 0.6 mm. The intervals $\beta$ between the rows of short bonding sections (adhesive bonding sections) were set at 7.5 mm, 10.0 mm, 15.0 mm, and 20.0 mm for four different application examples. After the adhesion-bonding of the first and second sheets, the sheet was impregnated with a detergent liquid, in which alcohol was contained in a water medium, producing bulging due to the elongation of the crepe wrinkles in the second sheets.

[0049]

Wiping sheets in which bonding sections had been subjected to a dot-shaped embossing were used as comparative examples. Wiping tests were carried out using wiping sheets with different intervals $\beta$ between the rows of short bonding sections. The same object as in the above mentioned test (1) was used as the object of testing (object to be wiped).

[0050]

An appropriate amount of dust and pulp was scattered on the

floor and with each above-mentioned application example and comparative example the floor was wiped five times. The condition of the floor after wiping was observed, and an evaluation using symbols ○, △, and × was carried out concerning the extent to which pulp and dust contaminants in the groove sections had been wiped away. After wiping, the state of collapse of the wrinkling was observed, and an evaluation was carried out using ○ if the degree of collapse was small, △ if there was some collapse, and × for cases in which considerable collapse had occurred. Furthermore, the thickness of the wiping sheet was measured prior to the wiping operation. The results of the tests above are shown in the Table II hereinbelow.

[0051]

Table II

| ① 接合部の列間の間隔β (mm) | | 7.5 | 10.0 | 15.0 | 20.0 | 比較例 ② |
|---|---|---|---|---|---|---|
| ③ 拭き取り試験 | ダスト ④ | ○ | ○ | ○ | △ | △ |
| | 開繊パルプ ⑤ | ○ | ○ | ○ | ○ | △ |
| ⑥ 拭き取り後のシワの潰れ度合 | | ○ | ○ | △ | × | — |
| ⑦ 見掛け厚み (mm) | | 2.43 | 2.44 | 2.53 | 2.53 | 0.75 |

Key: 1 Interval β (mm) between rows of bonding sections
2 Comparative examples
3 Wiping test
4 Dust
5 Pulp

6 Degree of collapse of wrinkles after wiping

7 Apparent thickness (mm)

[0052]

As shown in Table II, in the case of the samples that had intervals β of 7.5 mm and 10.0 mm between rows of short bonding sections, the length of the ridge-and-valley wrinkling (B) in direction X generated between the rows was adequate, and the thickness of the sheets was considerable at 2.43 mm and 2.44 mm, respectively, which provided for bulkiness. In addition, because the thickness of the ridge-and-valley wrinkling (B) between the rows in direction X was adequate, the stiffness of the wrinkles was high, which provided superior strength during wiping. Thus, it was possible to cleanly wipe dust and pulp. In addition, the extent of collapse of the wrinkling was small. Even after continuous wiping, the sheets had high bulkiness and were easy to grip by hand.

[0053]

In the case of the sample that had an interval β of 15.0 mm, the bulge of the second sheets (S2) increased, and the sheet was thicker than in the case of intervals β of 7.5 mm and 10.0 mm. Its apparent thickness was 2.53 mm. In addition, clean wiping of dust and pulp was also possible. However, because the dimension of the ridge-and-valley wrinkling in direction X between the rows was significant, the stiffness of the ridge-and-valley wrinkling was somewhat weaker so that wrinkles were slightly collapsed after wiping.

[0054]

Additionally, in the case of the sample in which the interval β was 20.0 mm, swelling of the wrinkles between rows was inevitable. Although the sheet was 2.53 mm thick, the dimension of the ridge-and-valley wrinkling in direction X was excessively elongated so that stiffness dropped, ridges and valleys were prone to collapse, and the efficiency of wiping somewhat decreased. In addition, in a comparative example in which dot-shaped bonding sections were formed all over the sheet, the surface area of the ridge portions was larger than that of the valley portions and there were few surface irregularities. As a result, the efficiency of wiping of dust and pulp was small.

[0055]

In the present invention, as shown in Figure 2, the ridge-and-valley wrinkling (B) in the region L between rows of short bonding sections and the ridge-and-valley wrinkling between rows of short bonding sections in the neighboring region L1 are separated by slanted short bonding sections (a) so independent ridge-and-valley wrinkling is formed between the rows of short bonding sections. Therefore, the interval β between the rows determines the length of each set of ridge-and-valley wrinkling (B) in direction X. If its length in direction X is considerable, the stiffness of the ridge-and-valley wrinkling (B) is weakened. If the intervals between the rows are short, the surface area occupied by the short bonding sections becomes excessively large, resulting in inferior bulky feel from the swelling of the second

sheets (S2). Thus, it is preferable that the interval between the rows of bonding sections be not less than 5.0 mm and not more than 15.0 mm. If this spacing is used for the rows, a certain height is imparted to the sheet, appropriate ridges and valleys can be formed all over the sheet, appropriate stiffness can be imparted by the adhesive bonding sections and superior wiping results are obtained. However, even if the interval β reaches 20.0 mm, with the exception of the fact that wrinkling may be prone to collapse, the sheet may exhibit a wiping efficiency superior to that of the prior-art.

[0056]

(3) Tests regarding the weight per area of the sheet

Tests were carried out using wiping sheets of Comparative Examples 1 and 2 and Application Examples 1-3 as shown below in order to determine the optimum weight per area of the first sheet and second sheet to maintain the bulkiness and flexibility of the sheet as well as that of a wiping sheet formed from these first and second sheets.

[0057]

A high-crepe paper with a crepe ratio of 50% and a weight per area of 15 $g/m^2$ made from pulp fiber was used for the second sheets and a paper with no crepe also made from pulp fiber with a weight per area of 15 $g/m^2$, which had not been subjected to creping, was used for the first sheet. A wiping sheet with sandwich construction, used as the sheet of Application Example 1, was formed by laminating second sheets on the front

and reverse sides of the first sheet. As for the bonding of the aforementioned first sheet to the second sheets, the front and reverse sides of the first sheet were partially coated with an adhesive, whereupon the first sheet and the second sheets were laminated, followed by application of pressure to the portions where the adhesive had been coated and adhesion-bonding of the sheets using heating plate embossing as shown in Figure 3. Based on the results of the above-mentioned tests (1) and (2), the adhesion bonding was carried out with interval $\alpha$ between the short bonding sections set at 0.6 mm and interval $\beta$ between the rows set at 7.5 mm. The aforementioned interval $\alpha$ and interval $\beta$ between rows are the same in Application Examples 2 and 3 and Comparative Examples 1 and 2 shown below. After bonding, the sheet was impregnated with a detergent liquid obtained by blending water and alcohol to produce a bulge between adhesive bonding sections (A) and (A) of the second sheets and in this manner bulky wiping sheet was formed.

[0058]

Application Example 2

In the same manner as in Application Example 1, sheets made from pulp fiber were used for the first and second sheets. A wiping sheet was formed with a weight per area of 30 g/m$^2$ for the first and second sheets, while other conditions, namely, the crepe ratio of the first and second sheets (paper with no crepe for the first sheet), the adhesive and bonding method used for adhering the first sheet to the second sheets, the interval $\alpha$ between the short bonding sections, the interval $\beta$, the detergent

liquid, and the like were all the same as in Application Example 1.

[0059]

Application Example 3

A wiping sheet was formed by changing the weight per area of the first sheet and second sheet, as compared with that of Application Example 1 and Application Example 2, to 70 $g/m^2$, with the rest of the conditions being absolutely the same. As comparative examples for the above-mentioned Application Examples 1-3, the following wiping sheets were formed.

[0060]

Comparative Example 1

In Comparative Example 1, the weight per area of the sheets, as compared with the above-mentioned Application Examples 1-3, was reduced, with the weight per area of the first sheet and second sheets set at 10 $g/m^2$. Other manufacturing conditions were absolutely the same as in Application Examples 1-3.

[0061]

Comparative Example 2

In Comparative Example 2, the weight per area of the sheets, as compared with the above-mentioned Application Examples 1-3,

was increased, with the weight per area of the first sheet and second sheets set at 70 g/m$^2$ [sic; 100g/m$^2$]. Other manufacturing conditions were absolutely the same as in Application Examples 1-3.

[0062]

The total weight per area of the wiping sheet in the above-mentioned Application Examples 1-3 and Comparative Examples 1 and 2, as well as the apparent thickness, and the thickness obtained after subjecting the sheet to pressure at 1 kg/cm$^2$ were measured and the softness of the sheets was investigated. The total weight per area was represented using (g/m$^2$), and thickness was represented using (mm). As for the softness of the sheets, a soft sheet was designated as ◎, a relatively soft one as ○, and insufficient softness was represented by ×. The results are shown in Table III.

[0063]

Table III

| | ⑧ | ⑧ | ⑨ | ⑨ | ⑨ |
|---|---|---|---|---|---|
| ① サンプル | 比較例1 | 比較例2 | 実施例1 | 実施例2 | 実施例3 |
| ② S2+S1+S2の目付 (g/m$^2$) | 30 | 300 | 45 | 90 | 210 |
| ③ S1の目付 (g/m$^2$) | 10 | 100 | 15 | 30 | 70 |
| ④ S2の目付 (g/m$^2$) | 10 | 100 | 15 | 30 | 70 |
| ⑤ 見掛け厚み (mm) | 2.4 | 2.5 | 2.4 | 2.4 | 2.45 |
| ⑥ 加圧後の厚み (mm) | 1.0 | 2.2 | 1.5 | 2.0 | 2.2 |
| ⑦ 柔らかさ | ◎ | × | ◎ | ○ | ○ |

Key: 1 Samples
2 Weight per area of S2+S1+S2
3 Weight per area of S1
4 Weight per area of S2
5 Apparent thickness
6 Thickness after pressing
7 Softness
8 Comparative Example
9 Application Example

[0064]

As is shown in Table III above, the weight per area of the wiping sheet of Application Example 1 was 45 g/m$^2$, its thickness was 2.4 mm and its thickness after application of pressure was 1.5 mm. In addition, the sheet was extremely soft and evaluated as ◎. The weight per area of the wiping sheet of Application Example 2 was 90 g/m$^2$, and its apparent thickness was 2.4 mm as in Application Example 1. Its thickness after application of pressure, however, was thicker than in Application Example 1, at 2.0 mm. The softness of the sheet was evaluated as ○, which shows that while its weight per area was greater, its softness was slightly lower than in Application Example 1. The total weight per area of the wiping sheet of Application Example 3 was 210 g/m$^2$, its apparent thickness was 2.45 mm, that is, slightly thicker than in Application Examples 1 and 2, while its thickness after application of pressure was 2.2 mm, or thicker than in Application Examples 1 2, which allowed it to provide a bulky feel. However, its softness was slightly lower than in Application Example 1 and was evaluated as ○.

[0065]

By contrast, in Comparative Example 1, the weight per area of each sheet was just 10 g/m$^2$, so that the total weight per area of the sheet was 30 g/m$^2$. Thus, although its thickness prior to application of pressure was 2.4 mm, the same as in the above-mentioned Application Examples 1-3, its thickness after application of pressure was very small, at 1.0 mm, and it was extremely soft. Additionally, in Comparative Example 2, the weight per area of each sheet was 100 g/m$^2$, with the total weight per area of the sheet being 300 g/m$^2$. Its thickness after application of pressure was considerable, at 2.2 mm, which enabled it to preserve a high sheet bulkiness. However, its softness was correspondingly low and was evaluated as ×.

[0066]

Based on the above-mentioned results, it is evident that if the weight per area of the first and second sheets is too small, softness is high, but thickness after application of pressure is insignificant and this does not permit preservation of the bulky feel during wiping. Its stiffness is weaker as well. Conversely, if the weight per area is too high, thickness after application of pressure is considerable and the bulkiness of the sheets is preserved at a high level during the wiping operation, but since the stiffness of the sheet is too high, it gives an unyielding tactile sensation, making it difficult to grip by hand and difficult for it to deform in accordance with the location being wiped, which makes wiping efficiency low. Therefore, the weight per area of each sheet should be preferably not less than 15 g/m$^2$

and not more than 75 g/m$^2$. As used in the aforementioned tests, in the case of three-layer construction with second sheets bonded to the front and reverse sides of a first sheet, the total weight per area of the sheet is preferably not less than 45 g/m$^2$ and not more than 225 g/m$^2$. In the case of two-layer construction with a first sheet and a second sheet, the total weight per area of the sheet should preferably be not less than 30 g/m$^2$ and not more than 150 g/m$^2$. A wiping sheet formed from sheets with such weight per area permits retention of a bulky feel during wiping and possesses softness, which makes it easy to grip by hand and allows for a high efficiency of wiping of contaminants.

[0067]

Effect of the invention

As was explained above, because in the present invention ridge-and-valley wrinkling is formed on the surface of the sheet, the invention provides a wiping sheet that is bulky and possesses a high wiping efficiency.

[0068]

Additionally, the ridge-and-valley wrinkling on the surface of the sheet is produced, for instance, due to a difference in the ratio of elongation of crepe wrinkling for different sheets, with length in direction X and pitch in direction Y of the ridge-and-valley wrinkling controlled using interval $\beta$ and interval $\alpha$ between the bonding sections formed in rows thereon. Thus, the invention provides a wiping sheet that has a voluminous

feel, increased strength of the ridge-and-valley wrinkling, resistance to collapse, and a superior effect in terms of wiping of contaminants.

## Brief description of the figures

Figure 1 is an oblique view showing the construction of the entire wiping sheet of the present invention.

Figure 2 is an enlargement of a portion of Figure 2 in a plan view showing the shape of the adhesive bonding sections and the wrinkles that appear as a result.

Figure 3 is a cross-sectional view showing part of the sequence of operations in the process of manufacturing the wiping sheet of the present invention.

Figure 4 is a cross-sectional view showing another example of the layered construction of the sheet.

## Brief explanation of the reference symbols

1 Wiping sheet
2 Adhesive
S1 First sheet
S2 Second sheets
A Adhesive bonding sections
B Wrinkles
a Short bonding sections
p Pitch of short bonding sections
$\alpha$ Interval between short bonding sections in the direction of rows
$\beta$ Interval between rows of short bonding sections.

$\gamma$ Width dimension of the short bonding sections.

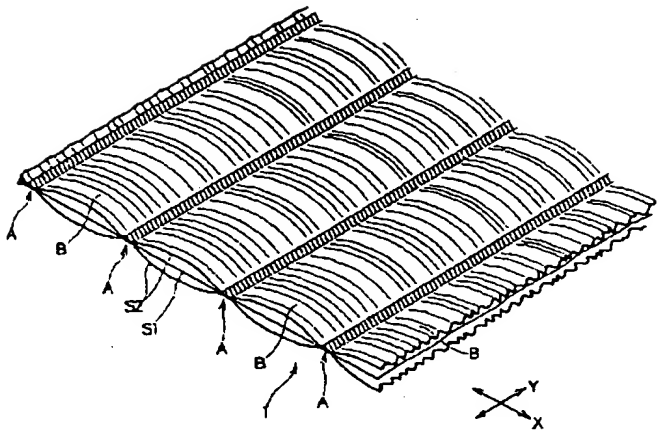



Figure 1

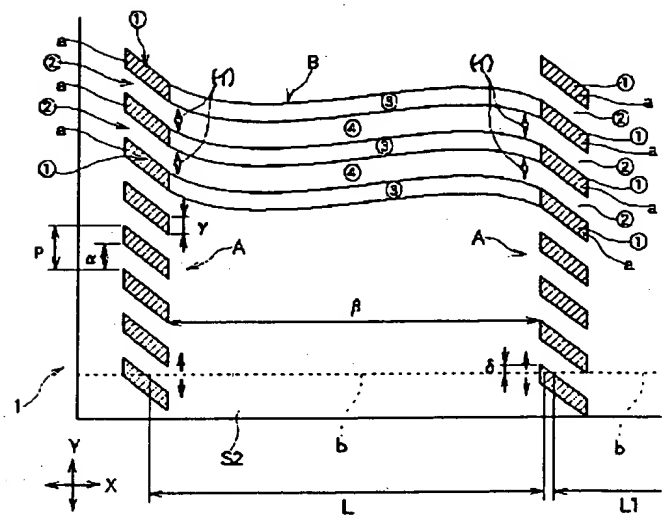



Figure 2

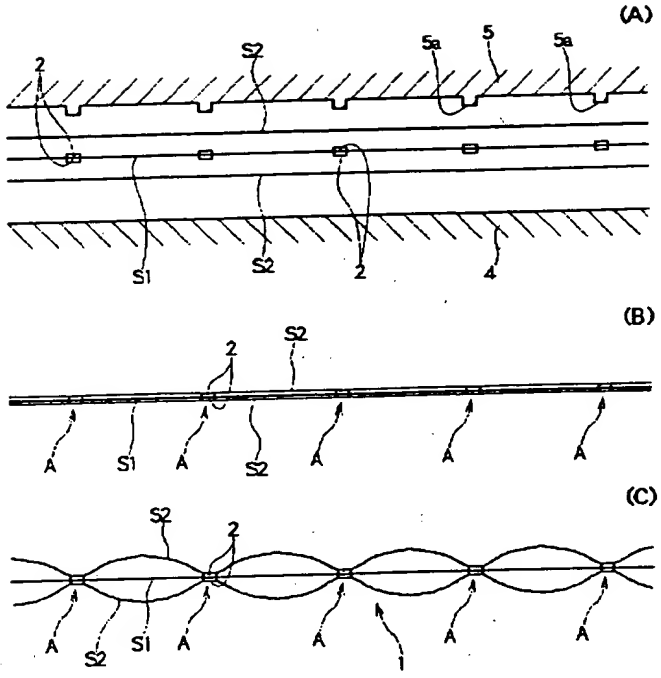



Figure 3

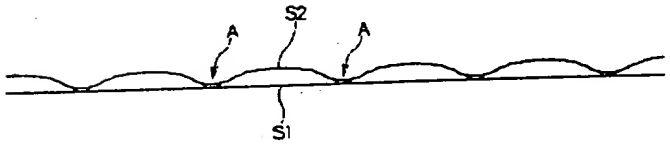



Figure 4